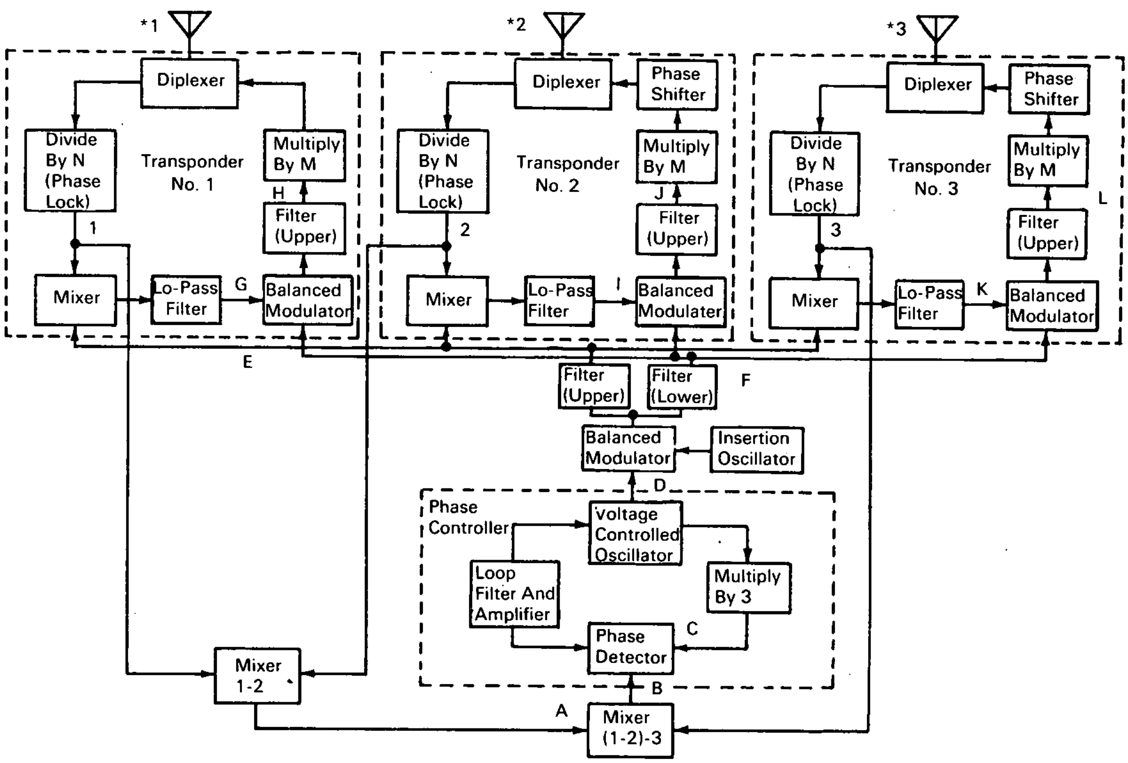
NASA TECH BRIEF

Interference Effects Eliminated in Random Oriented Space Station



Antenna System

A system has been devised to eliminate destructive interference effects among multiple omnidirectional or semi-omnidirectional antennas on a large space vehicle that is either spin-stabilized or randomly oriented relative to the ground station with which communication is necessary.

The system includes three transponders located in near proximity to three antennas. The portion of the signal to be used for the transmitter frequency and phase determination is divided down by means of phase-locked frequency dividers to a frequency for which the phase controller unit is designed. This frequency would be on the order of 30 to 60 Mc. The response of the phase-locked frequency divider is such that it will respond to the frequency changes attributable to the relative velocity with respect to the ground station and the rotational velocity and orientation of the vehicle but not to pseudo-noise or modulation. The divided signals at points in the block diagram designated by 1, 2, and 3 are fed to the phase controller. Signals 1 and 2 are mixed together and their sum product, signal A, is then mixed with signal 3 and the sum product of this mixing action, signal B, is taken.

(continued overleaf)

Signal B now contains the phase and doppler components of all three input signals. If the point of reference for the expressions of the input signals is taken at the point of symmetry for the antennas, the phase and doppler components will cancel at point B provided that no additional components are added by the system. Signal B is then fed to the phase detector of a phase-locked oscillator circuit and compared in phase to signal C, which is derived from the controlled oscillator. The output of the phase detector is filtered and amplified and used to control the oscillator. The oscillator frequency is one third of that of signal B. The loop is completed by means of a times-three frequency multiplier.

The oscillator output, D, goes to a balanced modulator, and is modulated by a frequency, ω_i, which is much higher than the doppler components or the down-link information content and yet much lower than the oscillator frequency. The balanced modulator output consists of the sum and difference frequencies with the original frequency suppressed. These two frequencies are separated by sideband filters to produce signals E and F. In actual practice phase-locked oscillators will regenerate signals E and F using the outputs of the filters as control. Down-link modulation is added at this point. Identical phase modulators (not shown) fed by signals E and F provide the modulation with minimal effects from signal treatment inequalities.

Signals E and F are fed back to the transponders at the ends of the modules. Signal E, which is the sum frequency product of the modulation of ω_i on the basic oscillator frequency, is applied to a mixer in each of the transponders and heterodyned with the divided-down input signals. The carrier and linear doppler frequency terms are eliminated in the difference frequency output of the mixer. Because signal E is higher in frequency than the input frequency, the rotational doppler and phase components in the mixer output signal, G, I, or K, are reversed in sense relative to ω_i, as compared to their sense relative to the input signals. The mixer output signals are filtered to eliminate the input frequencies and the sum product and fed to balanced modulators. The other input frequency to the balanced modulators in the transponders is signal F. Signal F is modulated by the mixer output signals and filtered so that only the upper sideband frequencies are present in the outputs. The result of this last process is to produce signals, H, J, or L, which contain divided-down signal components of the ground station transmitter signal frequency, linear doppler in its original sense, and rotational doppler and phase in reversed sense. These signals are then frequency multiplied to the desired output frequency and transmitted via the diplexer and the same antenna used for reception. When the effects of the rotational velocity and antenna positions are taken into account in translating these signals to a common wavefront plane normal to the direction of the ground station, the rotational doppler and spatial phase relationships will have been cancelled out and the signal powers will add.

Note:

Inquiries concerning this invention may be directed to:

Technology Utilization Officer
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Houston, Texas 77058
Reference: B67-10435

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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